INTERVIEW WITH CAPTAIN ZDENKA WILLIS DEPUTY NAVIGATOR OF THE NAVY (CNO-N7/CN)

On July 26, the Navy announced a revolutionary change to the traditional paper chart method of navigation that has been used by the surface and submarine fleet for more than 50 years. The Navy will go to an all-digital nautical navigation system by October 2009. Under the Electronic Chart Display and Information System - Navy (ECDIS-N), the Navy expects to increase safety, accuracy, reliability and accountability during deployments.

The ECDIS-N system interfaces with the ship's Global Positioning System receivers and other navigation sensors to give the ship's watchstanders a computerized real-time view of the ship's position and movement on an electronic-chart display. It also provides an automated capability for route planning and Digital Nautical Chart® correction to include the latest "Notice to Mariners" information.

CHIPS asked the deputy navigator of the Navy, Capt. Zdenka Willis, to explain the features of ECDIS-N and its impact on the Navy's warfighting mission.

CHIPS: Why have you called ECDIS-N, "the single biggest advancement to navigation since the advent of radar."

Capt. Willis: ECDIS-N, in conjunction with the Global Positioning System (GPS) and Digital Nautical Chart, provides superior navigation capabilities using an interactive computer system. For instance, in traditional navigation there is a time delay between taking a navigational position, plotting it on a chart and comparing it to the planned route. During this time the ship is normally moving, so the plot represents where the ship was at the time the position was taken, not where it currently is. But ECDIS-N, using a secure GPS connection, instantaneously updates and displays the ship's position. In a dangerous combat situation, or even a crowded seaway, this can provide a huge advantage.

ECDIS-N will also increase accuracy. A majority of navigational errors are human in origin. The most common mistakes are made in adding, subtracting and manually plotting the position on a chart. ECDIS-N will greatly enhance the safety of navigating at sea. Another common problem that affects safety is the difficulty in manually updating paper charts with new information and ensuring that the ship's chart inventory is current. ECDIS-N allows automated updating of the digital charts, via Net download or mailed compact discs. This will significantly decrease the tedious workload of correcting charts.

One of the most powerful tools of ECDIS-N systems is the automatic grounding avoidance feature found in route planning and route monitoring. Automatic grounding avoidance correlates the ship's position, draft and safety ellipse with the chart and generates alarms if the system detects potential hazards along the ship's track. The system also provides a full set of alarms if the system is malfunctioning.

CHIPS: What is revolutionary about ECDIS-N?

Capt. Willis: The most important aspect of this system is the integration of the GPS and other positional sensors, with radar and 'smart' charting databases to provide a continuous plot of where the ship is, any hazards to that ship and the location of other vessels in the area. GPS is a significant advancement, but without ECDIS-N, a petty officer would read the GPS position, go to a chart and plot the position, then figure out where the ship is

Deputy Navigator of the Navy, Capt. Zdenka Willis, in her office at the U.S. Naval Observatory in northwest Washington, D.C. Over her shoulder is a portrait of Lt. Matthew Fontaine Maury, known as the "Pathfinder of the Seas." With his love of plotting the seas, Maury studied navigation, meteorology and currents. In 1842, Maury was named superintendent of the Depot of Charts and Instruments. The Depot of Charts and Instruments later became the U.S. Naval Observatory and, in 1844, Maury served as its first superintendent.

in relationship to the planned inertial movement of the ship. It was a time consuming process and by the time you were done a couple of minutes had passed. So when you went to the officer of the deck and said here is our position, it really wasn't your position because the ship was moving. In a tight navigation or combat situation where seconds are precious, this is automated; there is no room for error. This is the biggest change for the Navy.

CHIPS: How long has ECDIS-N been in testing?

Capt. Willis: Navy began testing ECDIS-N with Voyage Management System software on submarines and surface ships in 2003. The VMS software is Windows-based. The same software is used on commercial ships. The databases used by ECDIS-N are the Digital Nautical Chart® (DNC) and a companion product called Tactical Ocean Data (TOD). TOD provides military and classified bathymetric data required by the Navy. These are produced by

the National Geospatial-Intelligence Agency (NGA) in the DoD standard format called Vector Product Format (VPF).

The VPF is a standard format, structure and organization for large geographic databases that are based on a georelational data model and are intended for direct use (i.e., you do not need to translate the data into another format to use). VPF allows application software to read data directly from computer-readable media without prior conversion to an intermediate form. VPF uses tables and indexes that permit direct access by spatial location and thematic content and is designed to be used with any digital geographic data in vector format that can be represented using nodes, edges and faces. VPF defines the format of data objects, and the georelational data model provides a data organization within which the software can manipulate the VPF data objects.

The software then reads the DNC and TOD data, both in VPF, and displays the data to a screen, so that it looks like the paper chart that the mariner is used to seeing. There are three sets of displays within ECDIS-N, the base layer, or the minimum amount of data that must be displayed; the standard layer, looks most like the paper charts, and then mariner overlay display that allows the mariner to add additional information needed for operations.

The software has tools that allow the watchstander to adjust the display to ambient light. There is a color scheme for bright sunshine and one more suited to evening hours. There is also a night-time color scheme because the bridge of a ship is in darkened mode. A computer screen that shows a lot of white would be blinding when you look outside at the dark night. Another feature of the software allows the watchstander to turn on and off layers of information to make the presentation on the screen most useful to him or her. Most significant, is that even if the data such as the soundings are turned off, the software continues to interact with the database and sounds an alarm if there is an impending danger to the vessel.

CHIPS: Which members of the ships' crew will use ECDIS-N?

Capt. Willis: Displays are available to the commanding officer, executive officer, and all of the watchstanders on the navigation bridge and in the combat information center. All the watchstanders (enlisted and officer) will be using ECDIS-N. The navigation team, prior to getting underway, will plan the ship's route and have the route approved by the commanding officer. While underway each of the watchstanders monitors the ECDIS-N system along with the real-time situation and the mission of the vessel. If the route needs to be changed for safety or mission requirements the watchstander can easily change the ship's voyage plan to meet the emerging needs. Procedures are in place to ensure that the appropriate approvals are obtained prior to making these changes. What ECDIS-N does is to automate the planning process and by querying the smart DNC and TOD data ensures that the route planned is a safe route.

Prior to ECDIS-N, voyage planning could take weeks to days. With ECDIS-N, planning is reduced to less than five hours, changes are easy to make, and 'what if' routes can be easily explored. Everybody has the ability to access the data on the system and make a query to look at the information behind the database. For example, if you have a buoy, one can query that buoy and find out everything there is to know about it.

Earlier this year as part of a fleet-wide program to upgrade the Navy's surface ships and submarines with ECDIS-N systems, ECDIS-N was installed on the Aegis guided-missile cruiser USS Cape St. George. On the St. George, for a routine underway watch there are three individuals on the bridge. The officer of the deck has overall responsibility for the safety of the ship, and there is a conning officer (trained in ship handling) and helmsman. ECDIS-N is used by each of these watchstanders to ensure the ship safely executes its mission.

Meanwhile in the combat information center, watchstanders are responsible for executing the mission of the ship. With ECDIS-N, they no longer have to plot the ship's position, required for many tactical evolutions, but now use the ECDIS-N to understand the ship's location and voyage plan. This frees up a watchstander who previously was required to plot the ship's position, improves accuracy since everyone is on the same sheet of music and allows the watchstanders to concentrate on mission execution.

CHIPS: What effect will the ECDIS-N have on warfighting capability?

Capt. Willis: Instantaneous plots will provide a tactical advantage in a combat situation, where seconds count. But ECDIS-N also allows the ability to overlay tactical data on the display, including the ship's surface search radar plot. We call this enhanced situational awareness; that is, knowing exactly where you are, where your assets are and where the enemy is. This will not only facilitate precise navigation but also other tactical applications.

CHIPS: What are some of the other components of ECDIS-N?

Capt. Willis: Radar overlay, as mentioned earlier, ECDIS-N allows the watchstanders to 'hook' tracks on the surface search radar and overlay them onto the DNCs. This allows a ship to have better situational awareness and better ability to manage the contact picture.

Shared awareness with the integration of digital charts, text material, alarms and danger queries, have increased the accessibility from two manually plotted displays to seven automated, interacting consoles. Aside from the manpower savings, this puts everyone on the same sheet of music on the bridge and in combat. No longer is everyone huddled around two different plots – one on the bridge and one in combat. ECDIS-N also associates visual and radar fixes with GPS positions, providing much better situational awareness in low visibility.

Playback feature is a significant step forward for training and assessment of the voyage. ECDIS-N provides what many consider a 'black box' recording for a vessel's track. In addition to the obvious legal use, it is useful for retracing a ship's course in the case of a man overboard situation and can be used as a training aid. External track steering mode allows the ship to be automatically driven without input from the ship's watchstanders. This

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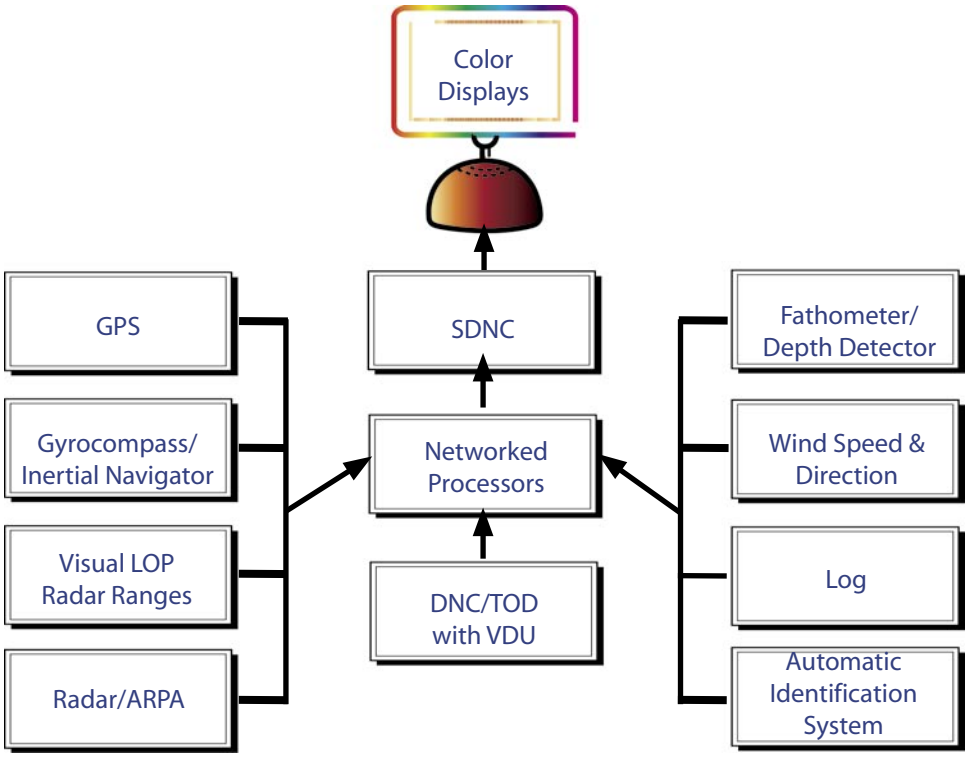
ECDIS-N COMPONENTS



functionality allows the deck watchstanders to act more as lookouts and safety observers, and it saves the Navy money by being fuel-efficient. The ECDIS-N system is constantly updating position, so precision anchorage can drive the ship to the precise anchorage point. ECDIS-N allows a user to input the swing and drag circles and activates an alarm if the anchor begins to drag or another ship is about to move within the danger circle.

The query function capability allows the navigation team to drill down for more than the normal displayed data. For instance, a Digital Nautical Chart of a harbor approach will show bathymetry and land data, approved navigation lanes, buoy and channel marker information, established landmarks for navigation fixes, hazards to navigation, etc. Hot links will allow easy access to additional information including photographic views of these features.

It also provides information about the reliability of the chart data. Ocean bottom data are critical to safe navigation, but only 60 percent of the ocean is surveyed to navigation standards and only 10 percent is surveyed to GPS standards. Many charts, by necessity, provide the only data currently available, which may be from very early or partial surveys. Because of this, it is critical for the watchstander to understand the data he or she is navigating from, and DNCs provide text information on the source and reliability of the survey data.

CHIPS: What do you mean "everyone will no longer be huddled around two different plots – one on the bridge and one in combat?"

Capt. Willis: Without ECDIS-N, petty officers on the bridge and in the combat information center are both plotting the position and trying to keep track of the entire situational picture. In the high tempo of combat operations this can lead to errors as multiple individuals are trying to read and plot the ship's position on more than one plot in two separate locations. The other watchstanders would crowd around the chart table on the bridge or in combat to execute the tactical mission or to navigate. Space was limited to those who could fit around the chart table, and the potential always exists that two different plots exist. Now with the distributive nature of ECDIS-N, the same navigation picture is displayed on multiple consoles both on the bridge and in combat — allowing everyone to see the same picture.

CHIPS: Can ECDIS-N capture uncharted data?

Capt. Willis: The technology exists within the system to accept and record input from the ship's position and fathometer systems. At this point, the fathometer information is not routinely collected. We are evaluating the feasibility and viability of this data and how we might send this data to the National Geospatial-Intelligence Agency and Naval Oceanographic Office for input to DNC and TOD databases.

The Navy has seven oceanographic survey ships that are in continuous use, basically driven 365 days a year to collect survey data. The NOAA, the National Oceanographic and Atmospheric Administration, surveys inside U.S. waters; the Navy surveys outside U.S. waters. Additionally, many other countries have survey vessels, and there are many agreements in place to share this data. Even with this global effort, only 40 percent of the world's oceans have been surveyed to hydrographic standards.

CHIPS: Why would a ship use external track steering mode?

Capt. Willis: The external track steering mode is an additional

capability for those ships that have a fully integrated bridge system. You can think of external track steering mode akin to cruise control in a car that also knows your route and keeps you on that route. It is most often used in long transits and while most of Navy operations are not of this nature, this feature can be used during transits. The St. George drove more than 900 miles to Nassau, the Bahamas in external track steering mode. This capability not only keeps the ship on track; it keeps it within 15 yards of its desired course. As well, the St. George transited in 'best fuel' mode and saved fuel on transit. This saved money and allowed the watchstanders to act more as safety observers than hands-on operators.

CHIPS: Does precision anchorage eliminate the need for a ship to request a harbor pilot to pull into port?

Capt. Willis: No. It is still standard practice for a ship that is coming into the harbor to use a harbor pilot. With the electronic systems onboard, the commanding officer and the harbor pilot will work together to bring the ship in. What ECDIS-N does is make this a much easier evolution. The harbor pilot has a lot of local knowledge.

The chart information is as good as we can have it. But on any given day in and out of port, there could be, just like on a highway, local construction that is transient in nature, so it doesn't show up on the chart. Coming into port you have traffic separation schemes on the water just as on the road. Bringing a harbor pilot onboard is a requirement of the port.

CHIPS: Is ECDIS-N based on commercial standards?

Capt. Willis: The Safety of Life at Sea (SOLAS) convention, initiated in 1914 and later administered by the U.N. International Maritime Organization (IMO), states that all commercial ships must carry up-to-date navigation charts. When the SOLAS convention was adopted, paper charts met the requirement. In November 1995, the IMO issued a resolution entitled Electronic Charting Display and Information System (ECDIS) that set the requirements that commercial vessels had to meet to safely replace paper charts with digital charts displayed on interactive computer systems.

The Navy determined that it was in our best interest to take advantage of what had been done in the civil sector. After all, ECDIS represented a 10-year worldwide effort that had been tested at sea. Further, the number of commercial SOLAS bound vessels (30,000) significantly outnumbers the Navy's inventory. Although DoD is not bound by U.N. conventions, it makes sense from both a safety and business perspective for Navy to follow the ECDIS performance standard as closely as possible.

When we reviewed the civil specifications, we determined that we could use it with only minor modifications that included: (1) Use of DoD standards for digital charting data – Digital Nautical Chart for surface operations and Tactical Ocean Data for underwater operations; (2) The ability to plot lines of positioning and to navigate the ship using dead reckoning; (3) Greater system reliability in a combat environment. These additions were made to the ECDIS resolution for the Navy variant, known as Electronic Charting Display Information System – Navy, or ECDIS-N.

CHIPS: Is there a transition plan to deploy the ECDIS-N to the fleet?

Capt. Willis: Yes, CNO (N6/7) is funding the ECDIS-N capability under several programs of record. The submarine fleet is receiving this capability under a radar upgrade program and surface ships from various modernization programs. New construction ships will receive the ECDIS-N capability as they are delivered to the fleet.

CHIPS: Who was involved in the development of the ECDIS-N?

Capt. Willis: This was a team effort that involved: the Office of the Oceanographer/Navigator of the Navy; various components of the Chief of Naval Operations staff; the Program Executive Office for Integrated Warfare Systems; the Program Executive Office for Ships; the Naval Surface Warfare Centers; the Space and Naval Warfare Systems Command; the Operational Test and Evaluation Force; and Northrop Grumman's Sperry Marine Division. This partnership extends to the fleet from the fleet commander who oversees the procedures, tactics and training, down to the commanding officer and crew of the ships and submarines who embrace the new technology.

CHIPS: Will ECDIS-N change the way navigation is taught?

Capt. Willis: Absolutely. A training plan is in place for installed systems and will be updated based on lessons learned. Overall responsibility for formal Navy school courses rests with the Naval Education and Training Command. Training of midshipman is already being provided at the U.S. Naval Academy and in a few ROTC units. In addition, Surface Warfare Officers School has incorporated ECDIS-N training into the curriculum and changes to the enlisted quartermaster school curriculum are being evaluated.

To address the needs of operational ships, training courses and associated electronic classrooms have been established at fleet concentration areas for both surface ships and submarines, with supplemental training provided as part of initial system installation or system upgrades. Changes are being incorporated into course material as lessons learned are provided by the fleet users. To make training material available to a broader audience and on an as needed basis, computer-based training is nearing completion and should be available in the near future.

CHIPS: Is ECDIS-N more difficult to learn than paper plotting?

Capt. Willis: The interface between the human and machine will make the process easier. We have found that most Sailors, with their computer backgrounds, take really quickly to the system. Understanding the basics of the system is pretty easy. The training gets to be how to be an expert on the system. We have to continue to teach basic seamanship because that does not go away. It will be awhile before we make the complete transition.

So Sailors are being taught to plot on paper, so they understand the mechanics behind what the computer is doing. I expect over the next three years that will be phased out, but we will still teach the navigation principles of how the computer is making the plots. CHIPS